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U. S. DEPARTMENT OF AGRICULTURE.

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B. T. GALLOWAY, *Chief of Bureau.*

THE WILD ALFALFAS AND CLOVERS OF SIBERIA, WITH A PERSPECTIVE VIEW OF THE ALFALFAS OF THE WORLD.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., February 27, 1909.

Sir: I have the honor to transmit herewith the manuscript of a paper by Prof. Niels Ebbesen Hansen, Agricultural Explorer of this Department and Professor of Horticulture in the South Dakota State College of Agriculture. The manuscript is a preliminary report on the wild alfalfas and clovers of Siberia, with a perspective view of the alfalfas of the world.

During the past twelve years Professor Hansen has made three trips to the colder regions of Europe and Asia in search of new alfalfas and other forage crops. The report deals with questions bearing on the crops discovered and introduced, and is respectfully recommended for publication.

On behalf of Professor Hansen I wish to express thanks for the great courtesy and kindness of all Russian officials and other citizens of the Empire of Russia, who did everything in their power to assist in his work.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE WILD ALFALFAS AND CLOVERS OF SIBERIA, WITH A PERSPECTIVE VIEW OF THE ALFALFAS OF THE WORLD.

INTRODUCTION.

On February 10, 1909, the writer returned to Washington from an eight months' tour to Siberia and Turkestan as Agricultural Explorer for the United States Department of Agriculture. This concluded his third tour to Siberia in search of a hardy alfalfa for the Prairie Northwest. These three expeditions were preceded by a visit to European Russia in 1894.

It had been his plan to say very little concerning the new plants obtained until they had been further tested, preferring that the seeds should tell their own story as to their value for this continent. However, the flood of correspondence indicates such great interest in this subject that it appears desirable at this time to present a preliminary report.

THE PREPARATION FOR THE WORK.

Upon entering the Cabinet in 1897, Secretary Wilson mapped out a comprehensive system of foreign explorations by which the number of economic plants now in cultivation in various parts of the United States was to be largely augmented by additions from other countries having similar conditions of soil and climate.

The writer had the honor to be appointed the first agricultural explorer. Three years previously, in the course of a four months' trip through eight countries of Europe, he had spent three weeks in European Russia studying the horticulture and agriculture of that empire. The trip served to direct his thoughts into unusual channels, especially in the line of breeding hardy fruits. This breeding work has occupied his attention ever since, and after raising seedlings by the hundreds of thousands some remarkable hybrids have been originated.

This line of breeding has led the writer to study the habitat and original distribution of many economic plants and to do considerable work in exploring our western wilds, where an occasional rattlesnake would add zest to the quest. The wise counsel of his teacher, Prof. J. L. Budd, and his observations from a trip through Russia gather-

ing fruits in 1882 have been remembered with great profit. Since September, 1895, in the writer's work at the agricultural college and experiment station of South Dakota, this question has continually presented itself: Why are some plants hardy and other plants tender as regards winter cold and summer heat? There must be some definite law underlying this great difference in hardiness.

THE FIRST JOURNEY TO SIBERIA.

The writer's first journey to Siberia was a ten months' tour, from June, 1897, to March, 1898, through eastern European Russia, Turkestan, western China, and Siberia. (See Pl. I.) As a result of this journey Turkestan alfalfa was imported into the United States for the first time. The exportation of Turkestan alfalfa, both to North and South America, has since assumed large proportions, as it has been found in certain localities to be more resistant to cold and drought than the ordinary alfalfa now in cultivation, which was brought by the Spaniards from North Africa to South America, perhaps three centuries ago, and later to California.

The trip of 1897 included an overland journey by wagon and sleigh of over two thousand miles from Tashkend, Turkestan, to Omsk, Siberia, via Kuldja, western China. Five carloads of various seeds and plants were obtained in the course of the ten months' tour.

The endeavor of 1897, as developed in the progress of the investigation, was to find the northernmost plants of *Medicago sativa*, the common alfalfa now cultivated. As nearly as could be determined, the northern limit was near Kopal, in southwestern Siberia. The severity of the winter made further work by the writer impossible. At one time he was one thousand miles from the nearest railroad. The hardships and perils of that journey are a matter of record.

At that time the writer had come to believe strongly that the botanical name of any species of plant was not enough for the purposes of agriculture; that a species extending over a wide geographical range differed widely in degrees of hardiness, especially in regard to cold; and that for the northern regions of the United States we must find the form that had been developed by nature in similar regions in the Old World. Hence the endeavor to get the most northern type of alfalfa in Asia for trial under similar conditions in North America, where no alfalfa is native.

THE SECOND JOURNEY TO SIBERIA.

Circumstances made it impossible for agricultural explorations to be resumed in Siberia for some time. The Spanish-American war, the Russian-Japanese war, and the Russian revolution all made

PROF. N. E. HANSEN

MAP SHOWING THE ROUTES TAKEN ON THREE JOURNEYS BY PROF. N. E. HANSEN

further work impracticable. In July, 1906, the second journey began, and this turned out to be a six months' trip around the world by way of England, Denmark, Lapland in northern Norway and Sweden, Finland, Siberia, Manchuria, and Japan. Some three hundred lots of various seeds and plants were obtained on this journey.

The writer learned that he was very nearly correct in his former estimate as to the northern limit of the common alfalfa in Asia, but that extending far north of this limit across Siberia were three wild species with yellow flowers instead of blue and that these were good forage plants in the driest and most severe regions of southern Siberia. The early settlers of Siberia learned the value of these species, as they put up wild hay for the stock and observed that the cattle, sheep, and horses on the ranges were fond of these plants. These three species were *Medicago falcata*, extending approximately over the western two-thirds of Siberia; *Medicago platycarpa*, found in a much more limited range in central and south-central Siberia, especially along the edge of timber and in timber clearings; and *Medicago ruthenica*, found in the remaining eastern portion of Siberia, Mongolia, and Manchuria. Associated with these were some wild clovers which it appeared equally desirable to obtain, especially for short rotations.

The lateness of the season when these species were found made it impossible to obtain the seed of more than one of the three, *Medicago falcata*. The intense interest manifested in this discovery upon returning to the United States showed the urgent need of hardier alfalfas and clovers than we now have for the prairie regions of the Northwest.

THE THIRD JOURNEY TO SIBERIA.

The third journey, of eight months, was for the purpose of gathering more seed of new forage plants, especially alfalfas and clovers, in Siberia. As the route homeward was through the Caucasus, the Mediterranean region, and North Africa, the writer was able to make a study of some other alfalfas, so that the present report might be termed a perspective view of the alfalfas of the world, or a study of alfalfa on four continents, especially the wild alfalfas of Siberia and the cultivated alfalfas native to Turkestan and the Mediterranean region. It is the story in brief outline of a persistent and determined effort to find out what nature has done toward making the alfalfa family adapted to regions of extreme cold, heat, and drought.

This third tour to Siberia was very greatly hampered by unfavorable weather; it was the wettest and most backward season known for many years and the seeds were not ripe at the usual time. The widespread epidemic of Asiatic cholera in Russia and Siberia, in

the midst of which the writer had to labor, did not facilitate the work. Some 300 lots of seeds and plants were obtained, however. On this journey a study was made of how people manage to live in some of the principal deserts of the world, including the Gobi Desert of Mongolia, the Salt Steppes of southern and southwestern Siberia, the Hunger Steppe of Turkestan, and the Sahara Desert of North Africa. An effort to extend this knowledge has been made by studying the work of numerous Russian explorers in Siberia and central Asia, so as to get a wider grasp of the subject. The remarkable fact developed that one alfalfa and one clover grow nearly, if not quite, at the northern limit of cold. This point is Verkhoyansk, in latitude 68° north, with a recorded minimum temperature of —67.8° C. (—90.04° F.). Yakutsk is in 62° north latitude, nearly due north of Lake Baikal, with a recorded minimum temperature of —64.4° C. (—83.92° F.). The northeastern limit of *Medicago falcata* and of *Trifolium lupinaster* is somewhere between Verkhoyansk and Yakutsk. Specimens of both plants have been collected on the Aldan River north of Yakutsk. In this region the subsoil remains permanently frozen.

In this extreme northern section of Siberia throughout an immense area are found the remains of the huge mastodons which at one time roamed over the plains. Their ivory tusks are still found in large quantities and are utilized, although usually much weathered after so many centuries of exposure.

It is of great interest to note that nature has furnished two legumes for this extreme north region. The mastodons of a former age have been succeeded by the hardy breeds of cattle and reindeer kept by native tribes and exiles. The time available, as well as his own preference, made the writer gather seeds in latitudes farther south, from 50° to 55° north, where with hot and dry summers there is much less snow at the time of the lowest temperatures, the mercury in the thermometers sometimes freezing with no snow on the ground.

In studies as to the sources of the seed the important fact should be borne in mind that the mere latitude and longitude do not tell the main story, but that isothermal lines and the amount of precipitation are the main factors in indicating climatic extremes. These have been the main guides in choosing the localities in which to gather seeds.

A FORECAST.

The writer has often been urged to make positive statements as to what the alfalfas and clovers brought from Siberia will do under field culture in the various regions of the United States. Inasmuch as he is not a prophet nor the son of a prophet he has steadily refused to do this. To the farmers of the Northwest who have lost millions

in all these years by the winterkilling of the common alfalfa and clover imported from the far milder regions of the Old World, he must give the admonition to be patient until the Department of Agriculture can definitely determine the value of these and other new introductions for the various regions of the Northwest.

The great difficulty of gathering seed in quantity in the wilderness makes it impracticable to send out the seeds to private planters, nor would it be desirable to do so until their real value has been determined. From a study of the climatic and soil conditions under which the seeds were gathered in Siberia, there are excellent reasons for believing that they will be found valuable in the colder and drier regions of the Northwest. They are not intended for regions where no trouble has been experienced from winterkilling of alfalfas and clovers under ordinary conditions. For such regions the writer would say, "Let well enough alone." His own belief is that these new plants will extend the present alfalfa and clover limits as far north on the American continent as anyone will wish to farm.

These alfalfas and clovers may be used in two ways: (1) As a cultivated crop for hay and pasture, and (2) to introduce as wild plants into the native ranges of the Prairie Northwest, where they will probably be able to hold their own with any plants now found there. As regards food value the peasants of Siberia have long ago determined that these alfalfas are suitable for all kinds of stock. *Medicago falcata*, especially, is no doubt an important factor in making the rich cream and butter for which Siberia is becoming noted.

THREE SIBERIAN ALFALFAS.

There are upward of 50 species of Medicago distributed through middle and southern Europe, especially in the Mediterranean region, western Asia, and North Africa. The group includes the useful snail clovers. Some are objectionable owing to their spiny pods, which cause trouble by getting into the wool of sheep.

The genus is well represented in the Caucasus, where there are at least 21 native species, along with 54 species of Trifolium, and there is abundant room for further explorations, especially in the mountain regions, for new species.

MEDICAGO FALCATA.

Geographical distribution.—*Medicago falcata* L., the name, "falcata" referring to the falcate or sickle-shaped pods, is distributed over a very wide area of Europe and Asia, but in the milder regions of its habitat it has been overshadowed by the common lucern, which has been under cultivation for a much longer period. It extends through a large part of western Europe, central and southern

Russia, the Crimea, the Caucasus, and through approximately the western two-thirds of Siberia, at least as far as 64° north latitude, through North China, the Trans-Caspian regions, including Turkestan and Persia, and through Afghanistan, western India, and Asia Minor. The extraordinarily wide distribution of this plant makes it necessary to be extremely careful in choosing the source of seeds.

Sir J. D. Hooker, in his "Flora of British India," states that the plant is found in Kashmir, Ladak, Kunawar, etc., and at an altitude of 5,000 to 13,000 feet in Afghanistan.

Moorcoft, in his article on the fruit trees of Kashmir, July 8, 1823, gives interesting notes on the cultivation of this yellow lucern in northwestern India. In a letter written in 1822 Moorcoft says that "the yellow lucern is a spontaneous production of this, is of a constitution more hardy than that of Europe, requires no other culture than that necessary for sowing it, and lasts for a long series of years."

This yellow-flowered lucern is considered by some authors to be the ancestor of the common alfalfa, but if so it must have been derived from the form of the species as found wild in its far south range, where civilization flourished in the earliest times. The Chinese have cultivated *Medicago sativa* from very early times and have *Medicago falcata* in cultivation in North China south of the Trans-Baikal region. However, this is far south of the region in which the writer secured seed in 1906 and 1908.

Medicago falcata in European Russia.—The agricultural experiment station at Besentsug, some 30 miles east of Samara in the Volga River region of eastern European Russia, is in the midst of a vast steppe region which has suffered from severe summer droughts and winter colds, often with but little snow. Recurring failures of crops have caused widespread distress at times among the peasants. This station has been recently established to help solve the dry-land agriculture problems for this region. *Medicago falcata* is found native here, and attention has been turned to it very recently as a valuable native plant adapted to cultivation. The trials at this station show that *Medicago sativa*, the French lucern as it is called in Europe, winterkills frequently and does not endure pasturing, while the native alfalfa, *Medicago falcata*, is of course perfectly hardy and endures pasturing for ten years at least. Under culture the plant is of upright habit except the first season, when it is somewhat reclining. It is a long-lived plant with a strong root system. The roots have been traced to a length of 10 feet and were still vigorous. Chemical analyses show that the protein content of the first cutting is superior by nearly 2 per cent to that of the common alfalfa, but in later cut-

tings the reverse is the case. Hence, it would seem best to cut early. Stock are very fond of this wild alfalfa.

The small experimental plots of the native form of *Medicago falcata* in southern European Russia in the Poltava and Kharkof provinces showed a strong upright growth, as strong as ordinary alfalfa (*Medicago sativa*). However, *Medicago falcata* is not cultivated to any extent in this region because the ordinary alfalfa has the start of it as a cultivated plant and the seed is plentiful and cheap.

At Moscow and other regions of western Russia where the climate is moister, clovers are more profitable in their shorter rotations than alfalfas.

Klingen, the Russian agronomist, found as many as one hundred branches from one plant of *Medicago falcata*. Where not pastured the plant is of strong, upright growth, standing fully waist high in the steppes, but where pastured closely it creeps and only the ends are erect. In general, Klingen finds that *Medicago falcata* stands pasturing, while *Medicago sativa* does not.

Medicago falcata is considered an excellent plant for bees, the flowers containing an abundance of nectar.

In his 1906 expedition the writer secured seed of *Medicago falcata* from Kharkof Province, southeastern Russia, S. P. I. No. 20717; from Omsk, Siberia, S. P. I. Nos. 20718 and 20719; from Irkutsk, eastern Siberia (from a load of wild hay), S. P. I. No. 20720; Samara Province in the Volga River region, S. P. I. Nos. 20721 and 20726; Saratov Province, central Volga River region, S. P. I. No. 20722; Don Province of the lower Volga River region, southeastern Russia, S. P. I. No. 20725; and Tomsk, Siberia, S. P. I. No. 20724.

Siberian field notes on Medicago falcata made in 1906 and 1908.— In 1906 and 1908 the writer found *Medicago falcata* to be a long-lived perennial with yellow flowers and with such a strong upright growth that it could be easily cut with a mower. Seed of this plant was gathered in many localities in 1906 from various parts of the Volga River region of eastern and southeastern Russia and in 1908 from a good many places ranging from the western boundary of Siberia to the Chinese border in the Trans-Baikal region, a distance of about 4,000 miles, but especially in the provinces of Tomsk, Akmolinsk, and Irkutsk. The choice of localities was decided by their similarity to the region of the Prairie Northwest, in which the alfalfas were designed to be tested. This species is especially abundant in the provinces of Tomsk and Akmolinsk, western Siberia. In 1908, traveling by wagon from Biisk to Semipalatinsk, in the vast plain lying just north of the Altai Mountains, which separates it from Mongolia, the writer learned in the course of a drive of 400 miles that *Medicago falcata* is one of the dominant and characteristic plants

of the steppe pastures and open range, holding its own with all the other vegetation. An abundance of hay is put up by the peasants, and the plant is highly esteemed in the wild pastures and ranges.

Wherever the range is not greatly overcrowded, especially with sheep, *Medicago falcata* is a fine upright plant 3 to 3½ feet in height. The abundant, bright yellow flowers are decidedly ornamental. Stock eat this plant greedily, and bees work on it industriously. It has a very strong root system. At 3 feet the taproot of one plant was still as large as a lead pencil.

The land here is divided into fenced tracts. Each village has one tract, usually greatly more than sufficient for its needs, but the population is rapidly increasing by immigration from European Russia.

Medicago falcata is a common plant in the wild hay offered for sale in the hay markets of the small towns along the line of the Siberian Railroad. The common name given it by the peasants is "scholtoe veseel," the first word meaning yellow, but "veseel" is sometimes applied to a vetch and to a clover in other regions of Russia.

In August, 1908, the writer found wild plants of *Medicago falcata* 5 feet 8 inches in length near Semipalatinsk. This was on the banks of the Irtish River in sandy soil mixed with some clay. In the open steppe 3 to 4 feet was a common height.

Medicago falcata is a very common wild plant all through this region. The peasants have so much land that they have not begun the cultivation of any alfalfas or clovers and will not need to with the present scarcity of population and as long as *Medicago falcata* is so abundant.

The personal observation of the writer was that horses, cattle, and sheep are extremely fond of the plant, and that it endures considerable pasturing. It was also learned that it is green very early in the spring, endures very severe summer droughts, stands dry upland soils underlaid with hardpan, and is considered resistant to alkali in the salt steppes of the south part of the Tomsk Province.

In 1906 the writer found this plant quite abundant on the eastern coast region of Lake Baikal in eastern Siberia, and a quantity of the seed was saved from hay brought in by the Buriats, a Mongolian tribe, from north of Irkutsk. The proximity of this great lake gives a greater rainfall here than out on the steppes, so that this form of the species may prove desirable in moist, cold regions such as Maine and northern Michigan. Lake Baikal may be termed approximately the eastern limit of the plant, although it was found in abundance at Werchne Udinsk, about 100 miles east of the lake. The extreme eastern point where it has been found is at Charonte, a few miles into Chinese territory, where an arm of the Gobi Desert extends across the Siberian Railroad.

MEDICAGO PLATYCARPA.

Medicago platycarpa Ledebour is a strong-growing perennial alfalfa with yellow flowers and large flat pods, found mainly in central Siberia. Its distribution is principally along the edges of timber and in open places in the native timber. Its native environment indicates that it should be tested in some sheltered regions, such as the timber sections of northern Minnesota and Wisconsin and westward into the Rocky Mountains. It is found in southeastern Siberia from the Province of Tobolsk west to Irkutsk and south into Mongolia, its main distribution, however, being in the southern part of the Province of Tomsk. In this province seed was gathered in 1908 at Chylim, east of the Obi River.

MEDICAGO RUTHENICA.

Medicago ruthenica Ledebour is a yellow-flowered wild perennial alfalfa extending approximately from the eastern shore of Lake Baikal to the Pacific Ocean; in Siberia extending southward into Manchuria, Mongolia, Korea, and northern China. Its northern limits, from the specimens collected so far, appear to be the central part of the Amur River and its tributaries. Seed was gathered the past season at Charonte, in an arm of the Gobi Desert, a few miles east of the Chinese border in the Mongolian portion of Manchuria. Manchuria proper begins in the Chingan Mountains, farther east. Here this plant was abundant and growing in nearly pure sand. In general it is found scattered in dry, stony soils. *Medicago ruthenica* is closely related to *Medicago falcata*, but the seed pods are flat and oval or tapering slightly at both ends, much like those of *M. platycarpa*, but smaller.

As a fodder plant this species is greatly relished by the cattle, horses, sheep, and camels kept by the native nomad Mongolians in the region where the seed was gathered. Its distribution in a general way may be said to be north of that of the common alfalfa (*Medicago sativa*).

The botanical descriptions indicate, as far as length of stem is concerned, that the three Siberian alfalfas, *Medicago falcata*, *M. platycarpa*, and *M. ruthenica*, are the same in length of stem, being given as 75 to 100 centimeters. The stems of *M. platycarpa* and *M. ruthenica* are smooth; those of *M. falcata* are somewhat hairy. The flowers of all three are yellow. The pods of *M. platycarpa* and *M. falcata* contain many seeds; those of *M. ruthenica* not usually more than four seeds. The seed pods of *M. falcata* are sickle shaped, while those of the other two are flat and somewhat oval.

FOUR OTHER ALFALFAS.

MEDICAGO SATIVA.

The common alfalfa, or lucern, is a native of the temperate regions of western Asia. According to Watt[a] the botanical evidence favors the inference that the original habitat of this plant extended from the northwest frontier of India to the shores of the Mediterranean. Watt further says that many writers regard *Medicago sativa* L., *M. falcata* L., and *M. media* Persoon as forming but one species. Other writers hold them to be varieties of one species, and still others believe that all three are distinct. Stebler and Schröter very justly maintain that to the agriculturist all three are very distinct. The ancient Indian literature is too vague to separate these alfalfas fully, so Watt describes all Indian notes without specific botanical distinction as to the species to which they allude. Stebler and Schröter state that lucern is indigenous to Asia, Anatolia, the southern Caucasus, Persia, Afghanistan, Baluchistan, and Kashmir. To this list should be added Bokhara and other parts of Turkestan, the vast region just north of Persia and Afghanistan. However, this plant has been cultivated in China since a very early date and further investigations may modify our notions somewhat as to its oriental distribution.

According to De Candolle the Romans brought lucern from Media four hundred and seventy years before the Christian era; hence the generic name, *Medicago*. The plant is mentioned by early Roman writers.

It is difficult to determine whether lucern is really indigenous to North Africa, but it is certain that it has been cultivated from a very early date and found its way to Spain centuries ago, perhaps at the time of the Moorish invasion, and was afterwards brought by the Spaniards to South America, and later to California. Some of it probably came over direct from Europe to America. In the light of the new theory of mutation we must regard this species as a collection of elementary species differing widely in character, some of which have been isolated under cultivation, but in none of them do we find the plant we desire for regions with extremely severe winter cold, especially with no snow on the ground.

The researches of Russian botanists show that *Medicago sativa* grows spontaneously in northern Korea, southern Manchuria and Mongolia, northern China, and all of Turkestan. Further research may serve to give more credit to the Chinese in developing *Medicago sativa* than we do now. One claim is that alfalfa followed the ancient southern caravan tracks westward many centuries ago. Certain it is that the plant was cultivated in Turkestan from very ancient times.

[a] Watt, George. Dictionary of the Economic Products of India. 1892.

The writer returned home from Siberia and Turkestan in January, 1909, via Trans-Caucasia, the Black Sea, and the Mediterranean Sea. He took occasion to visit the Sahara Desert in northern Africa to study the alfalfa as cultivated by the Arabs. In asking an Arab at Biskra if the alfalfa he grew was not secured by him from the French, it was amusing to note his eagerness to insist that on the contrary the French had obtained it from the Arabs. Alfalfa is one of the favorite plants of the oases, where it has been grown from time immemorial.

The point to which particular attention is directed is that so far no pure strain of *Medicago sativa* has appeared which is sufficiently hardy for the northern tier of States in the Prairie Northwest—that is, none that has not suffered at times from winterkilling. In other words, we have been endeavoring to cultivate common alfalfa far north of its ancient limits, and the process is fairly successful in regions of abundant snowfall, as the snow serves as a perfect winter protection. But there is a large area in the Prairie Northwest where the most severe cold comes occasionally with no snow on the ground. An example of this was in February, 1899, when millions of dollars' worth of common alfalfa was lost from our northern boundary south to Kansas.

The writer's ideal is an alfalfa that will never winterkill under the most severe conditions that can be found in the Prairie Northwest.

Medicago sativa turkestanica.—Probably the hardiest form of *Medicago sativa* is the one introduced from Turkestan in 1898. This proved more resistant to drought and cold than the ordinary alfalfa in cultivation in the United States. In his second trip to Turkestan in 1908, after a lapse of eleven years, the writer was interested in learning of the remarkable growth of the export of Turkestan alfalfa seed. On good authority he learned that 200,000 poods[a] go out of the khanate of Khiva alone, and perhaps upwards of 100,000 poods from the remaining sections of Turkestan. This may be explained by the multitude of camels in Turkestan which eat the old dry stems after the plants have been left standing for seed. The larger part of this seed goes to South America, where the area to which the plant is adapted is larger than that in the United States.

A danger now confronts the industry, owing to the fact that the seed passes through the hands of so many middlemen and a certain amount of seed is shipped from southern Persia by the Caspian Sea which also goes into the market under the same name. Efforts are being made to correct this, as seed of the far southern region can scarcely be expected to be as cold resistant as the more northern types.

[a] A Russian pood equals 32 pounds.

The name "turkestanica" is not a botanical name, but one given by Russian agronomists to distinguish the alfalfa found in Russian Turkestan and central Asia. S. P. I. No. 20711, from Prof. V. R. Williams, at Moscow, was originally from a single plant found at Tashkend, the capital of Russian Turkestan. At Moscow, Professor Williams has found this strain very hardy, very productive, and a beautiful plant, while the French lucern, by which is meant the ordinary cultivated alfalfa of Europe and North Africa, is winter-killed.

MEDICAGO MEDIA.

Sand lucern.—Lucern is only another name for alfalfa and is the one most commonly used in Europe. Sand lucern (*Medicago media* Persoon) is usually regarded as a natural hybrid of *Medicago falcata* and *M. sativa.* The flowers of sand lucern vary from pale yellow to green and violet. It appears that where the two species overlap in Europe and Asia natural hybrids occur, although not abundantly, and the hybrid ranges farther north than *Medicago sativa.* This hybrid origin makes our work with the ordinary sand lucern uncertain, as we do not know the exact origin of the two parents. Some of the strains of common alfalfa now in cultivation appear to be pure types of this species, and whether they are not really hybrid mixtures with *Medicago falcata* remains to be determined. This problem is now in the process of investigation by the Department of Agriculture.

In the light of the previous discussion of the varying hardiness of a species of a plant extending over a wide area it is reasonable to suppose that the native sand lucern of northern Sweden, western Siberia, and the Volga River region of eastern Russia would not be of the same degree of hardiness as the native sand lucern of Hungary and other parts of southern Europe. A very interesting field for further work is opened up for plant breeders by the importation of these new types of wild and cultivated alfalfas from various places in Europe and Asia.

It would be of great interest to make the cross referred to artificially in order to see whether nature's work can be reproduced. Experiments should also be made in crossing strains of definitely known origin of these two species of alfalfa to determine the best combination. In other words, nature has pointed the way by giving us a good hybrid alfalfa, but it may not be the best one that it is possible to make.

Sand lucern in Russia.—In 1897 the writer learned of the existence of sand lucern in Russia in his tour of the Volga River region. It is native in this region of eastern Russia. It is found at least as far north as Perm Province and is called "sand lucern" by the peasants.

In 1907 seed descended from a single plant grown in Voronezh Province of the lower Volga River region was obtained. This spontaneous or natural hybrid will sometimes have yellow flowers on one branch and blue flowers on another, or both on one branch. As already stated, sand lucern is considered to be a natural hybrid of *Medicago sativa* and *Medicago falcata* (S. P. I. No. 20714). S. P. I. No. 20715 is from the same region, but bears yellow flowers and is in fact almost *Medicago falcata* in its characteristics. S. P. I. No. 20716, from the same region, is a plant of vigorous growth, very hardy and productive, with black-green flowers. These three lots of seed were selected by Professor Williams, of the Agricultural College at Moscow.

In 1906 the writer secured seed of sand lucern from north Sweden, 60° north latitude (S. P. I. No. 20571). The plant appears to be in cultivation more in Hungary than elsewhere in Europe.

Herbarium specimens from lower Austria at the Imperial Botanic Garden in St. Petersburg were marked as growing spontaneously among the parent species, *Medicago sativa* and *M. falcata*, and there were also specimens from the rocks on the eastern shore of the Caspian Sea.

MEDICAGO GLUTINOSA.

Medicago glutinosa Bieberstein is a native of the Caucasus Mountains and Trans-Caucasia generally, especially of Armenia, where it is found up to a height of 7,500 feet. It is the only one of the 21 species of Medicago native of Caucasia which the writer thought worthy of introduction. His intention was to secure seed when returning through the Caucasus from Turkestan, but it was too late in the season and there was too much snow in the mountains to make this feasible. When it is obtained, it should be from the very dry upland region surrounding Mount Ararat in Armenia, the mountain mentioned in the eighth chapter of Genesis.

This plant is closely related to the *Medicago falcata* of western Siberia, the main distinction being the minute glutinous hairs found on the seed pods and young shoots.

MEDICAGO ARBOREA.

Medicago arborea L. is the largest representative of the Medicago genus, attaining a height of upwards of 10 feet. It is a native of the Mediterranean region of Europe, Asia, and North Africa, and is the "cytisus" mentioned by ancient Greek and Roman writers as an excellent forage plant. It is especially common on the islands of the Greek archipelago and in southern Italy. It is cultivated to a limited

extent in various portions of its range, but as it gets woody too quickly and is less productive, the ordinary lucern is much more in favor. It is a favorite wild plant, as it furnishes rich feed for cattle, sheep, and goats. In old plants the wood is dark and hard like ebony, and its use for saber handles, canes, and beads is recorded.

The writer's personal observations in gathering wild seeds of this plant are confined to Mount Lycabetos at Athens, near Mars Hill, on which the Apostle Paul preached to the Athenians, and to the cliffs near the outskirts of Naples, Italy, where the plants were found growing in the crevices of rocks, where they were inaccessible to any live stock. The plants seemed to flourish in the driest possible crevices in almost perpendicular cliffs where, apparently, no water could get to them.

Medicago arborea appears of value in hot, dry places where few other plants will live, but its greatest value is perhaps to be looked for from the standpoint of breeding. Some of its remarkable vigor of growth could with advantage be imparted to the other Medicagos of more northern origin. This species has been tried in a limited way in southern California as an ornamental plant, and north of its main range in Europe is considered only as an ornamental shrub needing winter protection. The large, bright yellow flowers are abundantly produced.

THE FUTURE ALFALFA FOR AMERICA.

From a personal study of the alfalfas on four continents as outlined in the foregoing pages, the thought has come very strongly to the writer that no one alfalfa has all the good points needed for our future agriculture. All of them, in the light of the mutation theory, are collections of elementary species varying widely in important characteristics.

This opens a vast field for the plant breeder. The elementary species which are the best for each particular region may be isolated by selection. Parallel with this line of experimentation should be carried on experiments in hybridization.

In the spring of 1908 the writer began this work independently in South Dakota by potting plants of several alfalfas obtained in his former tours to Asia, with a view to hybridization. However, the idea is not wholly new, experiments having been started independently by the Department of Agriculture. Nature has already pointed out the way in the natural hybrid known as *Medicago media*, or sand lucern. There are many combinations possible, and it is a promising field for the plant breeder, especially since Mendel's law of heredity has given us a quick method of breeding hybrids true to seed. This, however, is a work for the plant breeder and not for the farmer. The

Siberian alfalfas, in their present unselected state, fresh from the wilds of Siberia, will, it is hoped, prove useful in solving the alfalfa problem in the Prairie Northwest.

NOTES ON THE CLOVERS OF EASTERN EUROPEAN RUSSIA AND SIBERIA.

There are more than 250 species of Trifolium in the temperate and subtropical regions of the Old World and North America; also in the mountains of tropical Africa and South America.

TRIFOLIUM PRATENSE—RED CLOVER.

The ordinary red clover (*Trifolium pratense* L.) is a native of Europe, North Africa, and northern and middle Asia. As cultivated in the United States it is quite a hairy plant, while smooth-leaved forms have been found in parts of Europe, especially in Norway and eastern Russia. The American red clover seed sometimes comes to Russia, owing to its cheapness, but is objected to by the Russian planters owing to the hairiness of the leaves, causing dusty hay and heaves in horses.

The smooth-leaved clover of the Volga River region of eastern Russia is now being tested in the United States as Orel clover under the direction of the Department of Agriculture. The form most in favor for the colder regions of European Russia is that from the Province of Perm, known as the Perm clover. It is perennial, living several years at least. This may turn out to be much the same strain as the Orel clover.

In Siberia red clover is found native over a wide area in the steppe region of western Siberia and south to the Altai Mountains and Turkestan and westward to the Trans-Baikal region. It is common in the south part of Tomsk Province, where seed was collected by the writer in 1908.

The white clover (*Trifolium repens*) is very widely distributed in Siberia and southward at least to the Mongolian and Pamir plateaus, as well as in Europe, North Africa, North America, and sub-Arctic America. A giant form from the upland meadows of north Italy is interesting. It is known as *Trifolium bianco lodigensis*. The writer found that it was being tested as a novelty at Moscow, Russia, in 1906, and that a form with dark red spotted leaves was being isolated.

PERM RED CLOVER.

In 1908 at the Agricultural College in Moscow the writer saw large fields of the Perm red clover, three or four years from the seed without resowing, all of luxuriant growth and showing the great vigor of

the plant. The Russian Government has been promoting the spread of this Perm red clover over other parts of Russia. At Moscow the comparative yields were as follows: Seed from southern Sweden, 4; seed from Orel, Russia, 12; seed from Perm, north of Orel, 18. As the Province of Perm is farther north than Orel, these yields in the severe climate of Moscow are suggestive and indicate that the plant is worthy of trial in the United States. The general low esteem in which American red clover is held in Russia indicates the need of improving the plant now in our cultivation. The main objection to our American clover, aside from its lesser hardiness, is its abundant hairiness and consequent dusty hay.

TRIFOLIUM MEDIUM.

In the Volga River region of eastern Russia great interest has been aroused in recent years in the native red clover of the dry steppes. This is especially the case since the frequent droughts of recent years. The form known as *Trifolium alpestre* Crantz, which according to other authorities is *Trifolium medium* L., has attracted especial attention owing to its deeper growing taproots.

The wild red clover is found all over Russia from the far north to the extreme south and from east to west. Russian authorities state that there are two varieties of this clover. The first has round leaves with a white spot; the second, with longer leaves, more pubescent than the first, of one color throughout, without the spot. The flower head of the second variety is longer than that of the first. The second variety deserves the first consideration, since it is more resistant to cold and drought. The characteristic that gives it very great value for dry regions is the very strong root system, consisting of deep-growing taproots with numerous laterals. These plants are found in complete possession of the dry steppes. The cultivation of this native dry-land clover as found in the dry regions of extreme eastern Russia is specially recommended by the Russian authorities, this variety being immensely superior to the red clover of western Europe, which extended tests show to be very decidedly lacking in hardiness.

The existence of the deep-growing taproots of this wild red clover was first discovered in 1903 in the Province of Samara, and experiments were begun in 1904. The great famine of eastern Russia, to alleviate which America rendered valuable aid, greatly stimulated the efforts of the Russian Government to find a plant and to determine methods of cultivation better adapted to this vast steppe region. The seed of this wild, taprooted clover ripens in the central part of the Province of Samara in the second half of July, but in old fields the seed ripens earlier than in those of more recent date.

Cattle are very fond of this wild clover, so much so that the plants do not have much of a chance where the range is overstocked.

TRIFOLIUM MONTANUM.

Trifolium montanum is a drought-resistant clover with white flowers found in the southeastern provinces of European Russia, such as Kharkof (S. P. I. No. 20655), Voronezh (S. P. I. No. 20656), and Saratov (S. P. I. No. 20660). The species does not appear to extend far into Siberia, botanical literature giving it as being rare in Omsk and Tomsk and as native of the southern part of the Province of Tobolsk, western Siberia. In the Volga River province it does not appear to be a heavy cropper, but is very drought resistant. There is room for more study of the affinities of the European and western Siberian red clovers and close allies.

TRIFOLIUM LUPINASTER.

Trifolium lupinaster L. may be termed the dominant representative of the clover genus in Siberia. It is very widely distributed, practically throughout the length and breadth of Siberia, extending farther north than any other type of the Trifoliums, and into Mongolia and Turkestan. Its northern range is in the vicinity of the Arctic Circle across Siberia. Specimens have been collected in the Province of Archangel, near the Arctic Circle in European Russia. It is an extremely abundant plant on the open steppes and is found along with the three species of Siberian alfalfa already mentioned. It is a perennial with a strong root system. The judgment of the writer is that it will not compete with the ordinary clover where that is perfectly hardy, but it is worthy of trial in our most northern and driest regions, owing to its perfect hardiness and capacity for resisting drought. It is very common in the wild hay offered on Siberian markets, and may be found to hold its own as a wild plant to introduce into our pastures.

The plant consists mainly of a single stem with few branches, with a cluster of large, rose-colored flowers at the top. The color varies, however, to light violet and even white. In the steppe regions of western Siberia, as elsewhere, it is a common practice for the peasants after they have raised a number of crops of wheat to abandon the field for several years. The weeds that come in at first are crowded out by the ordinary grasses, and along with them this clover holds its own and seeds freely, showing great vigor under unfavorable circumstances.

"Lupinaster" means "similar to the lupine," referring to the five leaflets similar to the lupine. Perhaps "Siberian lupine clover" will

be a good name for the plant in case it should be found suitable for growing on our northern borders. In the Province of Tomsk it has been found on alkali soils. At Moscow the suggestion was made that it may be necessary to scratch the seed of this clover before planting to insure even germination, as it is now well understood that this is necessary for a number of legumes to secure the best results in germination. European seedsmen now have machines for scratching leguminous seeds.

TRIFOLIUM SUAVEOLENS—PERSIAN CLOVER.

Trifolium suaveolens Willd. is native in southern Europe, North Africa to Persia, and in Afghanistan and India. In his trip to Russia and Turkestan in 1908 the writer heard of the Persian clover Schabdar, which was being introduced under government auspices into Turkestan from northeastern Persia as a valuable annual clover for rotation in the cotton-growing region. Previous to this time the Department of Agriculture had received from India seed[a] of two local varieties of the shaftal clover, which is considered one of the best forage plants in India and botanically appears to be a cultivated form of this species. In the course of the summer it was also learned that this Persian clover Schabdar belonged to this species, and it seemed advisable to obtain as much seed as possible from northeastern Persia, this being the most northeastern point where it was in cultivation.

This is a plant of extremely vigorous growth, but is sensitive to night frosts and needs hot summers for its best development. In Persia and Afghanistan usually the third growth is left standing for seed. Farther north, in Turkestan, the limit of the strain on the north border of the cotton belt, experience shows that it is better to cut it only once for fodder and to leave the second growth for seed.

The botanical name of this plant, *Trifolium suaveolens*, means "sweet scented." The flowers are small and sweet. They contain a large quantity of honey and are a great favorite with the bees. The lateness of the season made it impracticable to go to Meshed, the capital of northeastern Persia, near the meeting point of Afghanistan, Turkestan, and Persia. Enough seed originally from Meshed and grown one year in Turkestan was obtained, however, at Tashkend and the Hunger Steppe, Turkestan, for a good trial. Since arriving home a shipment of nearly six hundred pounds has been received direct

[a] This seed (S. P. I. Nos. 19506 and 19507) was presented to the Department of Agriculture by Mr. Philip Parker, experimental officer in the irrigation service of India, through Mr. Charles J. Brand, of the Bureau of Plant Industry, in December, 1906.

from Meshed. It appears probable that this plant will be found valuable in the regions of the most extreme heat in the Southwest. Plenty of bacteria nodules are formed the first year, as was found on examining the plant in the field at Tashkend.

CAN PLANTS BE ACCLIMATIZED TO ENDURE A GREATER DEGREE OF COLD?

Some of the most fundamental problems in agriculture and horticulture in the United States depend upon the right answer to this question. In view of the fact that the writer's opinion on this subject differs materially from those usually held, it appears only fair in this connection to define briefly his position, as outlined during the past few years in a number of addresses and bulletins. The discussion may be divided into (1) annual plants, or those enduring but one season, and (2) perennial plants, those living more than one year.

ACCLIMATIZATION OF ANNUAL PLANTS.

The history of cultivated annual plants has been quoted as an exception to the law that plants can not be acclimatized to a greater degree of cold. Indian corn, for example, in its native tropical and semitropical home in South America attains a height of 20 feet, requiring seven months for maturity, and has kernels several times the size of ordinary corn. The Indians before Columbus discovered America had already completed the work of carrying the plant northward on the American continent into Canada, but the plant has simply been dwarfed and shortened in its period of maturity. It still needs extreme heat for a part of the growing season, and no variety has been originated which is adapted to the cool nights of northern Europe.

The theory of mutations has thrown a new light on the subject of acclimatizing annual plants. It appears that the ordinary botanical species usually consists of a number of elementary species or distinct mutations. By the critical methods of observation of Doctor Nilsson and his associates at the experiment station at Svalof, Sweden, new varieties of cereals are being produced by isolating mutations. The Swedish Select oat imported by the United States Department of Agriculture is one of the results of this work.

This work may be described in another way by saying that elementary species are being isolated from systematic species. An ordinary variety of barley, for example, may consist of a number of elementary species or distinct mutations. These, in the course of years, have adjusted themselves in a more or less constant proportion to meet the conditions of a given locality. When the seed is now

transported to a new environment the relative proportions of these elementary species are rearranged to meet the new conditions. For example, if a variety of barley is taken northward the extra-early elementary species within the limit of the variety soon outnumber the later maturing mutations, and if taken too far north the late sorts are soon entirely eliminated. Doctor Nilsson believes that a very early variety which will be adapted to far northern conditions may be originated far south, because the early mutations will surely appear whether the variety is raised north or south, and the problem is mainly the isolation of these early mutations when they appear.

ACCLIMATIZATION OF PERENNIAL PLANTS.

It is worthy of note that the many failures in farming in the semiarid regions of the West are due to the fact that the plants cultivated are from the milder regions of central Europe, showing that it is unwise to farm in a dry, cold climate with wet, warm climate plants. This is a very fundamental proposition, but the farmers of America have spent hundreds of millions of dollars in a vain effort to acclimatize certain plants.

Let it now be placed on record that his study of horticultural problems in the Prairie Northwest during the past twenty years has taught the writer to have no faith in the possibility of acclimatizing perennial plants to a greater degree of cold than that to which they are accustomed in their original habitat. Why is it that some trees and shrubs live and others die at a temperature of —40° F. with the ground bare of snow? In the endeavor to answer this question in the study of hundreds of kinds of fruit and ornamental trees and shrubs it appears that those native to a cold climate prove hardy, while those from a milder region are winterkilled. On the other hand, it appears that the original source of the seed makes a great difference. The box elder, red cedar, and many other trees from southern seed prove short lived and tender in the north, while trees of the same species of northern origin were hardy at the north. It appears, then, that for horticultural purposes the botanical name is entirely insufficient; that there is a difference in the species that can not be defined in botanical terms.

The writer does not believe in giving plants winter protection, as that is horticulture on crutches, and hence undesirable. In his first trip to Russia in 1894 he became interested in the results of Russian experiments with seed of evergreens from the northern regions of Russia and western Siberia as compared with seed of the same species from western Europe. In each case the native Russian seed had given plants of superior hardiness. It appeared then that nature was

able to acclimatize the same species to widely different regions, but there was no means of determining the length of time which had been taken for this work. This thought came to mind in reading the following in the "Origin of Cultivated Plants," by De Candolle:

> The northern limits of wild species * * * have not changed within historic times, although the seeds are carried frequently and continually to the north of each limit. Periods of more than four or five thousand years or changements of form and duration are needed apparently to produce a modification in a plant which will allow it to support a greater degree of cold.

Combining these two fundamental propositions, it seems possible to take full advantage of the great work done for us by nature in acclimatizing plants and to cultivate farther north the hardiest form of a species instead of the form adapted in the course of thousands of years to a moist climate. We should "hitch our wagon to a star," but should be careful to pick out the star that is going the right way for our purpose.

This fundamental thought, to work *with* and not *against* Nature in adapting plants to our prairie conditions, should underlie all efforts in the improvement of plants.

Concisely stated, the writer's belief is that plants can not be brought to endure any greater degree of cold to any noteworthy extent; that hardiness can not be bred into plants by selection alone. The ability to endure cold is probably a unit characteristic of the species which may be imparted by hybridizing. In fact, in his work in originating many hybrids between hardy and tender fruits at the South Dakota Agricultural Experiment Station, he has obtained hardy plants from the seed of tender varieties by hybridizing with the hardy ones, showing that the hardy male parent can transmit its hardiness even when the female parent species is tender.

The only other way in which acclimatization might possibly occur is by some great mutation or sudden change in the species, according to De Vries's theory of mutation. It appears as the result of De Vries's experiments that new varieties of plants and animals may originate as freaks or sports which are capable of reproducing true to seed. The writer has summarized this in the statement that evolution may be likened to a kangaroo rather than a snail; that changes that were formerly thought to demand thousands of years really take place suddenly. Applying this thought to the history of Shorthorn cattle, for instance, the "Champion of England," who stamped himself so indelibly upon the breed, was really a mutation and fully prepotent in his ability to transmit his perfect points.

A hardy plant may appear from tender stock, then, as a mutation, but so far, out of many instances, as in the case of the apple, rasp-

berry, grape, alfalfa, and clover, no noteworthy progress has been made in making plants hardier by selection from tender stock. It is like the never-ending work of Sisyphus.

There is much discussion as to acclimatizing alfalfa, but the occasional test winters, such as that of 1898–9, in which millions of dollars' worth of alfalfa was destroyed in the West and Northwest, indicate that it is not feasible to get hardy plants by selecting from tender stock. In each and every case it is starting on a work that may take many thousands of years for completion and the test winters may compel us to begin all over again. Nature takes a century of centuries for some experiments; let us leave such work to her. In other words, the writer has believed that those who were attempting to acclimatize the alfalfa brought over from Africa by the Spaniards and which reached California by way of the Spanish settlements in South America were starting on a ten-thousand-year job, and hence on one that they could never finish.

This is applying De Candolle's law to agricultural problems. Hence the overland journey of 2,000 miles in 1897–8 in northern Turkestan, western China, and southern Siberia, in an endeavor to find the hardiest form of the common alfalfa.

To return to Siberia in 1908, after a lapse of eleven years, and to learn that nature had done the work of breeding a hardy alfalfa was indeed a great pleasure. It is hoped that it will help in solving the alfalfa question on the North American continent. It appears as a sensible proposition for the United States, in the task of developing our natural agricultural resources, to take advantage of the work of nature through countless ages in other regions of the world. National or patriotic sentiment has no reference to plant life. We should be cosmopolitan and get as many kinds of economic plants from as many regions as possible, bring them together here, and let the fittest survive. We shall be satisfied with nothing less than the best of everything for every region. That is the fundamental thought of the agricultural exploration work which has been planned and carried out during the past twelve years by the present Secretary of Agriculture.

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